

# findings

*The outside lanes of I-10 near Pomona, California required major pavement rehabilitation.*

California faces a quandary common in many states; an aging urban freeway system. With over 1,800 lane miles (3,000 lane-km) of pavement needing rehabilitation, California's Department of Transportation (Caltrans) decided to research the best methods for constructing long-life pavements while minimizing traffic delays and inconvenience to the motoring public. For the initial study, they selected a 8-mile (5-km) stretch of I-10 near Pomona for rehabilitation, using a series of repeated night-time closures and one 55-hour weekend closure. In the weekend closure, the contractor earned a \$500,000 bonus for successfully removing and replacing a single lane of concrete pavement 1.7 miles (2.8 km) long.

During the 55-hour period, the two outside lanes of the four-lane eastbound roadway were closed. Public traffic continued to use the two inside lanes, separated by a movable concrete barrier.

Performance during the 55-hour closure indicates that state agencies can be confident that the reconstruction of 1.7 lane-miles (2.8 lane-km) of pavement in a week-end is an achievable goal. Through the sponsorship of the Innovative Pavement Research Foundation, a research team from the University of California at Berkeley (UCB) was present throughout the 55-hour closure, observing and fully documenting the process in order to determine the influence of the various construction activities on the productivity rate of reconstruction.

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*Fig. 1 - Non-impact demolition was concurrent with paving operations on the I-10 reconstruction near Pomona, CA. Excavator is loading cut sections of the pavement slabs into trucks for hauling to dump area 5 miles (8 km) away.*



*Fig. 2 - Concrete discharge and paving operation with roller screed used to strike off the fast-setting concrete. Tie bars have been epoxied into drilled holes in the adjacent lanes.*

## The Reconstruction Process

The pavement being replaced during the weekend closure consisted of 615 slabs that were 8 in. thick, 12 ft. wide, and 15 ft. long (200 mm thick, 3.6 m wide, and 4.5 m long). Since the underlying base in most cases did not have to be replaced, the slabs were removed by non-impact demolition. Slabs were sawed into pieces, then removed and placed into waiting dump trucks (Fig. 1).

Historically, California built jointed plain concrete without longitudinal tie or transverse dowel bars; however current design calls for both. After slab removal and cleanup of the base, tie bar holes were drilled into the edge of the adjacent slabs. Tie bars inserted into the holes were secured with fast-setting epoxy and dowel baskets were installed at the transverse joint locations.

For this project, Caltrans specified fast-setting concrete that develops strength rapidly, permitting traffic on the new sections as early as 4 hours after concrete placement. Job specifications required 400 psi (2.8 MPa) flexural strength at 4 hours and 600 psi (4.2 MPa) at 28 days. All 4-hour flexural tests met the requirement, and 28-day results were 10 percent higher than specified.

A dry-mix batch plant was set up to mix the concrete since the special concrete could harden in a central drum plant, slowing concrete production. Similarly, concrete ready mix trucks were used because constant agitation was required to prevent the fast-setting concrete from hardening in the mixer drums. The concrete was batched in 8 cubic yard (6 cu m) loads, which were then dumped into the 10 cu yd (7.5 cu m) concrete ready mix trucks.

Because of site access restrictions as well as potential buildup of concrete on a slipform paver, concrete was placed using a rolling screed. (Fig. 2). Two laborers followed the screed, floating, troweling, and brooming the pavement surface. Curing compound was sprayed on immediately after finishing and texturing (Fig. 3), and transverse joints were sawed about 2 hours later. The contract provided for diamond grinding of the surface for smoothness following the weekend closure.

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### Productivity Comparison: Nighttime vs. Weekend Closure

Activity	Nighttime Closure		Weekend Closure
	7-hours	10-hours	
Net working hours pouring concrete	2 hours	5 hours	43 hours
Auxiliary hours: mobilization/ curing/ demobilization	5 hours	5 hours	8 hours
Number of slabs* replaced	15	50	615
Productivity, slabs per hour	7.5	10	14
Major resources: dump trucks	7	7	21
	4	8	12

\* Slabs were 0.2 m thick, 3.6 m wide, and 4.5 m long (roughly 8 in. x 12 ft. x 15 ft.)

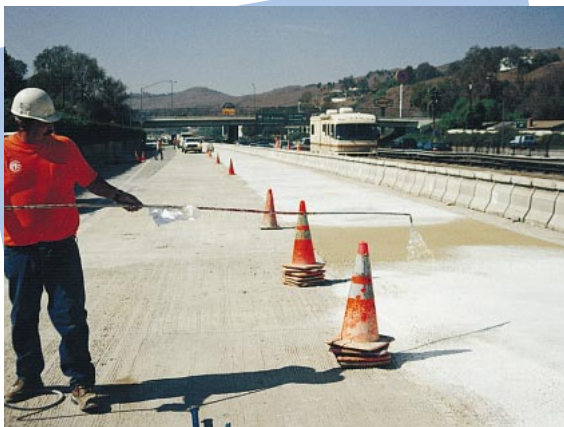
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*The 55 hour weekend closure allowed for the complete removal and replacement of 1.7 lane-miles of concrete. To complete this at night, it would have taken 17 night-time closures to complete the work.*

### Conclusions from Construction Activity

Analyzing the collected data, UCB researchers drew several conclusions:

- A major constraint limiting the rehabilitation production was the number of access lanes available to the contractor. Other major constraining factors were concrete delivery and discharge at the site. Productivity was limited in part by factors relating to the special concrete mix—such as use of smaller concrete loads and the need for washing and chipping out the mixer drums to prevent and remove buildup of concrete materials.
- Comparing production on nighttime and weekend closures, the weekend closure of 55 hours averaged 14 slabs demolished and replaced per hour, while 10-hour nighttime closure produced 10 slabs per hour and 7-hour nighttime closure yielded 7.5 slabs per hour (see table).
- The higher productivity of the weekend closure is a bonus for road users. The work accomplished by the contractor in a single weekend closure would have taken 17 nights of lane closures to complete.
- Decreasing the curing time by using the special concrete mix is absolutely required for short construction windows such as 7 to 10-hour nighttime closures. For longer closures for lane improvement, especially when an entire lane of sequential slabs is being replaced, portland cement concrete (PCC) may be more appropriate, reserving rapid-strength-gain materials for use only at the very end of the project.



*Fig. 3 - Worker applies curing compound immediately after finishing. Transverse joints were sawed 2 hours later.*

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## Constructibility Analysis by Computer

The UCB team used data from the 55-hour weekend closure to validate a previously developed computer program that predicts the amount of concrete pavement that can be replaced in a short window of time. Paving contractors and transportation agencies can now use the UCB constructibility model as a planning and analysis tool.

The computer analysis can be applied to either concurrent working method—in which demolition of the old slab and paving of the new occur simultaneously—or the sequential method in which paving does not start until demolition is complete. When the number of trucks available to remove demolished concrete and deliver new concrete can be accurately predicted, the program will show the length of pavement that can be rehabilitated within a specified period of time. For more information, contact the Institute of Transportation Studies, Pavement Research Center, at the University of California, Berkeley.

## Resource List

1. Lee, E.B.; Roesler, J.R.; Harvey, J. T.; and Ibbs, C. W., "Case Study of Urban Concrete Pavement Reconstruction and Traffic Management for the I-10 (Pomona, CA) Project," prepared for the Innovative Pavement Research Foundation by the Institute of Transportation Studies, Pavement Research Center, at the University of California, Berkeley, May 2000.
2. "Weekend Reconstruction - Urban Concrete Pavement on Interstate 10." Special Report 001P, Innovative Pavement Research Foundation, Falls Church, Virginia.

Both reports can be obtained in electronic format (pdf) from the Innovative Pavement Research Foundation.